

**EFFECT OF CONFIGURATION VARIABLES ON THE
SUBSONIC LONGITUDINAL STABILITY CHARACTERISTICS
OF A HIGH-TAIL TRANSPORT CONFIGURATION**

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SUMMARY

An investigation has been made to determine the effects at high angles of attack of configuration variables on the static aerodynamic characteristics of a typical high-tail transport configuration. Tests were made in the Langley high-speed 7- by 10-foot tunnel at a Mach number of 0.21 and a Reynolds number of 0.78×10^6 , based on the wing mean aerodynamic chord. Data are also included from tests made in the Langley transonic dynamics tunnel to determine the effect of Mach number. The test angle-of-attack range extended from about -5° to 50° .

The configuration variables which were investigated included body size and shape, nacelle size and location, wing section, and horizontal-tail vertical position, size, and taper ratio. The effects of wing leading-edge devices and wing double-slotted flaps on the longitudinal aerodynamic characteristics were determined for the basic high-tail configuration. In addition, the control effectiveness of the horizontal stabilizers and the effectiveness of the spoiler, aileron, and rudder controls were determined for selected test configurations to angles of attack of about 50° . Preliminary sideslip effects were also determined for the basic configuration.

The investigation showed that nonlinearity of the post-stall pitching-moment curve was traceable, to a large extent, to the nacelle wake which at high angles of attack blankets the horizontal tail. The fuselage-forebody lift, at high angles of attack, was also shown to influence the pitch curve past the stall of the wing. Factors such as increased fuselage cross-section size and increased forebody length aggravated the post-stall pitch nonlinearity, but fuselage wake effects did not change the available tail power to any appreciable extent.

Increased horizontal-tail size was shown to have a favorable effect on the post-stall pitch curve. Auxiliary horizontal-tail surfaces located low on the after part of the fuselage provided a similar but more pronounced linearizing effect. Significant improvements in the post-stall pitching-moment characteristics were obtained by relocating the aft-mounted nacelles to positions where the nacelles were shielded by the wake of the wing or fuselage.

A	aspect ratio, b^2/S
b	reference wing span, 46.40 inches (117.86 centimeters)
c	local chord of airfoil, inches (centimeters)
\bar{c}	mean aerodynamic chord of basic wing, 6.69 inches (16.99 centimeters)
C_D	drag coefficient, $\frac{\text{Drag}}{qS}$
C_L	lift coefficient, $\frac{\text{Lift}}{qS}$
C_l	rolling-moment coefficient, $\frac{\text{Rolling moment}}{qSb}$
$C_{l\beta}$	effective dihedral parameter, $\partial C_l / \partial \beta$
C_m	pitching-moment coefficient, $\frac{\text{Pitching moment}}{qS\bar{c}}$
C_n	yawing-moment coefficient, $\frac{\text{Yawing moment}}{qSb}$
$C_{n\beta}$	directional stability parameter, $\partial C_n / \partial \beta$
C_y	side-force coefficient, $\frac{\text{Side force}}{qS}$
L/D	lift-drag ratio
$(L/D)_{\max}$	maximum lift-drag ratio
M	free-stream Mach number
q	free-stream dynamic pressure, pounds per square foot (newton per square meter)
S	area of basic wing, including body intercept, 1.92 square feet (0.1784 square meter)
S_a	area of auxiliary horizontal tail, square feet (square meters)
S_t	area of horizontal tail, square feet (square meters)
R	Reynolds number based on \bar{c}
x	longitudinal distance from the leading edge of airfoil section, measured in reference plane

z_u vertical distance from airfoil section reference plane to upper surface of airfoil (positive direction up)
 z_l vertical distance from airfoil section reference plane to lower surface of airfoil (positive direction up)
 z_t vertical distance from wing reference plane to horizontal tail reference plane (positive direction up)
 i_t incidence of horizontal tail (negative trailing edge up), degrees
 α angle of attack, degrees
 δ_a deflection of aileron (negative trailing edge up), degrees
 δ_r deflection of rudder (negative trailing edge right), degrees
 β sideslip angle, degrees

Model components:

B_1 "pear-shaped" body having larger radius on top
 B_2 "pear-shaped" body having larger radius on bottom
 B_3 circular body
 B_{11} small body
 B_5 combination of B_1 and B_2 . B_2 shape forward and B_1 shape rearward
 B_6 shortened B_1
 W_1 basic wing, having NACA 64A409 airfoil section
 W_2 basic wing equipped with double-slotted flaps
 W_3 wing having NACA 23012 airfoil section
 H_1 small horizontal tail having taper ratio 0.29 and $\frac{S_t}{S} = 0.17$
 H_2 medium horizontal tail having taper ratio 0.29 and $\frac{S_t}{S} = 0.22$
 H_3 large horizontal tail having taper ratio 0.29 and $\frac{S_t}{S} = 0.30$
 H_4 large horizontal tail having taper ratio 1.00 and $\frac{S_t}{S} = 0.28$

N ₁	small nacelle
N ₂	medium (basic) nacelle
N ₃	large nacelle
V ₁	vertical tail having horizontal-tail pivot 10.80 inches (27.43 centimeters) above wing reference plane
V ₂	vertical tail having horizontal-tail pivot 12.80 inches (32.51 centimeters) above wing reference plane
V ₃	vertical tail having horizontal-tail pivot 8.80 inches (22.35 centimeters) above wing reference plane
V ₄	vertical tail having horizontal-tail pivot 6.90 inches (17.53 centimeters) above wing reference plane
V ₅	vertical tail having horizontal-tail pivot in wing reference plane
V ₆	vertical tail having horizontal-tail pivot 1.0 inch (2.54 centimeters) below wing reference plane
H _{A1}	small auxiliary horizontal tail having $\frac{S_a}{S} = 0.04$
H _{A2}	medium auxiliary horizontal tail having $\frac{S_a}{S} = 0.08$
H _{A3}	large auxiliary horizontal tail having $\frac{S_a}{S} = 0.13$
S	full-span spoiler on upper surface of right wing panel
S ₁	inboard spoiler on upper surface of right wing panel

DESCRIPTION OF MODELS

Drawings of four of the test configurations, various model components, and nacelle arrangements are presented in figures 1(a) to (m). Photographs of the basic configuration installed in the two test facilities are shown in figure 2. The geometric characteristics of the model components and ordinates of the high-lift devices are presented in tables I and II, respectively.

Bodies

The typical cross section of the basic body B₁ had slightly flattened sides, a circular bottom portion, and a larger circular top portion. Except

